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TOOLS OF THE TRADE

The development of earthquake early warning methods

Millions of people around the world live in regions of high seismic hazard, where damaging shaking due to earthquakes can occur. Although several natural 'warning signs' have been proposed (ranging from frog behaviours to cloud patterns), there remains no known way to robustly determine when or where an earthquake might occur prior to its rupture. However, detecting tremors soon after they occur, and immediately distributing alert messages to areas most likely to experience strong shaking, is a realistic and promising alternative. Such systems, known as 'earthquake early warning', or EEW, systems have the potential to minimize the damage and injuries from large earthquakes.

Various EEW algorithms have been developed and are currently being tested and deployed in countries worldwide. EPIC, one such EEW algorithm, contributes to the ShakeAlert system developed by the USGS, to provide alerts to the US West Coast. Public alerts via wireless emergency alerts (WEA) and third-party cell phone apps (such as MyShake, ShakeAlertLA and QuakeAlertUSA) are currently available in California. EPIC detects an earthquake using a network of seismometers. When at least four stations have been triggered by the shaking, EPIC rapidly estimates the location and magnitude of the earthquake, which ShakeAlert then uses to generate predictions of where strong shaking will be felt. A previous version of the algorithm, ElarmS v. 2.0, provided faster alert times than the other ShakeAlert algorithms. However, it created a substantial number of false alerts. Development of the latest version of the algorithm (first called ElarmS v. 3.0, now renamed EPIC) aims to minimize false alerts by including a teleseismic filter and a series of waveform checks to prevent false alerts. In addition, the EPIC team is now exploring the addition of machine learning techniques to correctly identify earthquake signals.

Though operational, the ShakeAlert system and the EPIC EEW algorithm are still under development. For example, during the M_w 7.1 earthquake near Ridgecrest, CA, USA, in July 2019, EPIC was able to quickly identify and locate the earthquake. However, the magnitude of the earthquake was underestimated by 0.8 magnitude units. As the other ShakeAlert algorithm FinDer (a finite-fault algorithm) also failed to correctly characterize the earthquake, no alert was distributed via the ShakeAlertLA app to users in Los Angeles County. Further modifications to the system after the July 2019 earthquake, including lower alerting threshold for third-party apps and developments to both ShakeAlert algorithms, mean that a similar earthquake in the future should create more accurate alerts, giving communities in the western USA warnings up to tens of seconds prior to maximum ground motion.

Credit: Photo courtesy of Jonah Merritt.

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